CHAPTER 8 CONDUCTOR STUDY

A preliminary conductor optimization study was performed for the 500kV AC alternative. The study considered electrical losses for given conductor power flows. An estimated future cost of power was calculated and discounted to a net present value for the various conductor scenario power losses. These costs were then added to expected line construction costs to determine a total cost for a given conductor system.

8.1 CONDUCTOR TYPES CONSIDERED

Selection of the conductor's mechanical strength is primarily dictated by the ice loading that the transmission line is expected to see. The conductor's strength is a function of the percentage of steel within the aluminum conductor, steel reinforced (ACSR) conductor. The geographic area is not expected to see significant icing events as compared with the rest of the United States. The conductor percentage of steel recommended for this line is 16%. This is common for many lines in the northwest. The percentage of steel for a conductor should be minimized as it will impact tower design and costs as well as conductor cost. It has been noted that the steel inside a conductor is the most expensive steel on a line.

The conductors considered in the study were triple bundled 954kcmil "Rail", 1272kcmil "Bittern", and 1590kcmil "Lapwing". In addition, a four bundle 795kcmil "Mallard" conductor system was also studied in the analysis. This conductor has a very high percentage of steel (39%) but was included for comparison purposes due to its use on the Colstrip 500kV lines.

8.2 OTHER CONDUCTORS AVAILABLE

For a line of this magnitude and cost, all available conductors should be considered. In recent years, a plethora of new conductors have been designed. These conductors have focused primarily on the ability of the conductor to carry as much current as possible through a fixed amount of aluminum without adversely impacting that conductor mechanically. Two of the most promising of these are the aluminum conductor, self supporting (ACSS) and aluminum conductor, composite core (ACCC) conductors (see Appendix C).

ACSS conductors utilize annealed aluminum strands. The annealing process removes nearly all of the temper or strength from the aluminum. This process insures that the tension of the conductor is completely carried by the steel strands of the conductor. This eliminates long term creep of aluminum and large variation of sag characteristic of standard ACSR conductors. ACSS conductor is the least expensive of the so-called high temperature conductors.

ACCC conductors are a new technology whereby annealed aluminum strands are supported by high strength carbon composite fibers. This conductor has virtually no difference in sag from high to low temperature. Because the technology is new, the conductor is very expensive but will likely reduce in coming years.

8.3 CONDUCTOR THERMAL CAPACITY

As opposed to lower voltage transmission lines, conductor thermal capacity is generally not the governing factor in conductor design for 500kV. The following are thermal capacities for the ACSR conductors studied.

Conductor	Thermal Capacity
4-795	3100MW
3-954	2500MW
3-1272	3000MW
3-1590	3450MW

Line loadings considered on the line were approximately 900MW with situations of 1200 and 1600MW studied for informational purposes. Because the conductor design is based on line losses rather than thermal limits, and the new high temperature conductors are significantly more expensive, they were not studied in detail.

8.4 LOSS ANALYSIS

For the 500kV transmission line design, losses were estimated by load flow analysis using the PSSE program and electrical models of Northwest Energy's system. These studies are included in Appendix D. The following are estimated losses realized at 800MW along the Townsend-Borah path:

Conductor	Losses (800MW Loading)
4-795	19.3MW
3-954	22.1MW
3-1272	17.1MW
3-1590	14.0MW

8.5 COST ANALYSIS

Obviously, flows will vary widely over a year. For estimating purposes, however, a scenario with 25% of the full line utilization was made. In addition, an estimated power cost of 70 mills was used based on current look ahead prices. A fifty year net present value of the future losses is calculated for the four conductor scenarios with assumptions included.

Conductor	Yearly Power Loss (25% Util.)	Yearly Cost @ 70mills	50 Year Present Value (8.5% Discount Rate)
4-795	42,267MW-hr	$2,958,690	$34,219,011
3-954	48,399MW-hr	$3,387,930	$39,183,428
3-1272	37,449MW-hr	$2,621,430	$30,318,399
3-1590	30,660MW-hr	$2,146,200	$24,822,081

Installed line costs were estimated for the four conductor scenarios and added to the line loss estimates to create overall line cost estimates.

Conductor	Estimated Installed Construction Cost	Present Value of Future Losses	Total Cost
4-795	$349,224,000	$34,219,011	$383,443,000
3-954	$305,827,000	$39,183,428	$345,010,000
3-1272	$327,242,000	$30,318,399	$357,560,000
3-1590	$350,834,000	$24,822,081	$375,657,000

The analysis indicates that the smaller conductor scenario is the lowest cost solution for the given assumptions. It should be noted that the losses analysis will significantly change based on loading assumptions. Because line losses are a function of current squared, the higher the loads on the line, the larger the difference in losses between the conductor systems will be. This in turn will show a lower total cost for larger conductor systems.

8.6 FUTURE STUDY

Because of the many assumptions used in the study, the need for future study and analysis is necessary. The need for an accurate estimate of the types and volume of power flow is essential for meaningful analysis. However, the preliminary study does indicate that for the stated project power flow requirement of 875MW, that a smaller conductor system is likely the more economical choice.

The difficulty in this sort of decision is that it does limit the line's ability in the case that future increased power flows will be required along the line. As such, the recommendation is to maintain the current estimating assumption of the three-bundle 1590 conductor system.